# Jabalpur Engineering College, Jabalpur

**(Declared Autonomous by MP Govt., Affiliated to RGPV, Bhopal)**
**(AICTE Model Curriculum Based Scheme)**
**Bachelor of Technology (B.Tech.) VI Semester (Electrical Engineering)**

**w.e.f. July 2023**

| S.No. | Subject Code | Category Code | Subject Name | Maximum Marks Allotted | | | | | Total Marks | Contact Hours Per Week | | | Total Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Theory | | | Practical | | | L | T | P | |
| | | | | End. Sem. | Mid Sem. Exam. | Quiz/ Assignment | End Sem. | Lab Work | | | | | |
| 1 | EE61 | PEC | Professional Elective Course-II | 70 | 20 | 10 | - | - | 100 | 3 | 1 | - | 4 |
| 2 | EE62 | OEC | Open Elective Course-I | 70 | 20 | 10 | - | - | 100 | 3 | 1 | - | 4 |
| 3 | EE63 | PCC | Microprocessor & Microcontroller | 70 | 20 | 10 | 30 | 20 | 150 | 3 | - | 2 | 4 |
| 4 | EE64 | PCC | Power Electronics-II | 70 | 20 | 10 | 30 | 20 | 150 | 3 | - | 2 | 4 |
| 5 | EE65 | PCC | Modern Power System | 70 | 20 | 10 | 30 | 20 | 150 | 3 | - | 2 | 4 |
| 6 | EE66 | PI | Minor Project | - | - | - | 60 | 40 | 100 | - | - | 4 | 2 |
| 7 | | MC | Industrial Training | Minimum Four weeks Duration. Evaluation will be done in 7th semester. | | | | | | | | | |
| | | | **Total** | **350** | **100** | **50** | **150** | **100** | **750** | **15** | 2 | **10** | **22** |
| 8 | EE67 | DLC | Self-Learning Presentation (SWAYAM/NPTEL/MOOC) | - | - | - | - | - | - | - | - | | 8 |
| 9 | EE68 | MC | NSS/NCC/Swatchhata Abhiyan/Rural Outreach | Qualifier | | | | | | | | | |
| Additional Course for Honours or Minor Specialization | | | | Permitted to opt for maximum 8 credits against additional MOOC courses in subject code EE67 for the award of Honours (Minor Specialization). | | | | | | | | | |

**Note:** 01. Departmental BOS will decide list of three/four optional subjects those are available in MOOC,OEC as well for PEC.
02. MOOC/NPTEL subjects shall be taken with permission of HOD/Coordinator.
03. Industrial training should be apart from laboratory work unertaken in the college rather it should have industrial orientation and practical aspects/field work. Report to be sbmitted at the beginning of 7th semester and students have to give a presentation in the Department. Evaluation will be done in 7th semester.

**Professional Elective Course-II**

| S.No. | Subject Code | Subject Name |
|---|---|---|
| 1 | EE61A | Advance Digital Communication |
| 2 | EE61B | Fundamental of Robotics |
| 3 | EE61C | Wind and Solar Energy Systems |

**Open Elective Course-I**

| S.No. | Subject Code | Subject Name |
|---|---|---|
| 1 | EE62A | Engineering Economics and Management |
| 2 | EE62B | Digital Control System |
| 3 | EE62C | Data Structure |

1 hour lecture (L) = 1 credit | 1 hour Tutorial (T) = 1 credit | 2 hour Practical (P) = 1 credit

PEC: Professional Elective Course, OEC: Open Elective Course, PCC: Professional Core Course, PI: Project and Internship, DLC: Distance Learning Course, MC: Mandatory Course

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**w.e.f.July 2023**

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|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | Practical | | Total Marks | L | T | P | |
| | | End Sem | Mid-Sem Exam | Quiz/ Assignment | End Sem | Lab work | | | | | |
| EE61A | Advance Digital Communication | 70 | 20 | 10 | - | - | 100 | 3 | 1 | - | 4 |

## ADVANCE DIGITAL COMMUNICATION

**Module-I:**
Digital PAM, binary PAM formats, line coding, band limited digital PAM systems Nyquist pulse shaping, equalization, synchronization techniques, bit and frame synchronization. Coded pulse modulation, voice digitization rate (VDR) of PCM, DPCM, DM, ADM, CVSD, log PCM, their performance comparison, VDR reduction by speech coding, VOCODERS, noise performance of PCM and DM, Digital multiplexes. AT & T and CCITT hierarchies, quasi-synchronous multiplexes

**Module-II:**
Digital CW modulation, BPSK, DPSK, DEPSK, QPSK, M PSK, QASK, BFSK, Doubinary encoding, QPR coherent and non-coherent systems, error probabilities in PSK, DPSK, FSK, QPSK, 16QAM, MSK, QPR and bit.

**Module-III:**
Matched correlation and optimum filters and symbol error rate

**Module-IV:**
Spread Spectrum techniques: DS, CAMA, FH, PN sequence, power requirement PN-sequence code, and Walsh code.

**Module-V:**
ISDN & Value added communication system simulation & Analysis using MATLAB &Simulink Application using communication toolboxes.

**Text Books:**

1. Haykins, "Digital Communication", Mc Graw Hill, First Edition.
2. B.P. Lathi, "Modern Digital & Analog Communication", Oxford University Press, Fourth Edition.

**Reference Book:**

1. A B Carlson, "Communication Systems", Mc Graw Hill, Fifth Edition.

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**Course Code:** **EE61A**
**Course Category: PEC**
**Course Name:** **Advance Digital Communication**

After successful completion of the course, student will be able to:

**CO-1:** Understand and appreciate the need of various Modulation and spread spectrum techniques.

**CO-2:** Analyze the properties of basic Modulation techniques and apply them to Digital Communication.

**CO-3**: Design and develop the different types of Modulation techniques, equalizer to improve the performance under fading channels for various applications.

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| EE61B | Fundamental of Robotics | 70 | 20 | 10 | - | - | 100 | 3 | 1 | - | 4 |

## FUNDAMENTAL OF ROBOTICS

**Module-I:**
Basic concept in robotics, classification and structure of robotics systems, the manipulators Drives and control systems, Kinetic analysis and coordinate transformation, The inverse kinematics problems, work space analysis and trajectory planning. Different motion and statics, joint space singularities, the manipulator Jacobin, induced joint torques and forces.

**Module-II:**
**Manipulator Dynamics:** Languages equation, kinetic and potential energy, Generalized force, Lagrange-Euler dynamic model, dynamic model of a two axis and three axis robot, direct and inverse dynamics, recursive Newton-Euler formulation, dynamic model of a one axis robot (Inverted Pendulum).

**Module-III:**
**Robot Control**: The control problem, state equations, constant solutions, linear feedback systems, single axis PID control PD-gravity control, computed torque control, Variable-structure control, impedance control.

**Module-IV:**
**Robot Vision**: Image representative template matching, polyhedral objects, Shape analysis, segmentation, iterative processing, and perspective transformation structures illumination.

**Module-V:**
**Task Planning:** Task- level programming, uncertainty configuration space, Gross motion planning, gross planning fine motion planning, simulation of planar motion, A task- planning problem.

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**Text Books:**


1. Robert J.Schilling, "Fundamentals of Robotic Analysis and Control", Robert J.Schilling Prentice- Hall of India, Pvt. Ltd, 1997 Edition.
2. Yoram-Koran, "Robotics for Engineers ", Mc Graw-Hill book company.


**Course Code : EE61B**
**Course Category : PEC**
**Course Name : Fundamental of Robotics**

After completion of this course students will be able to –

**CO1:** Understand basic components of Robotics, classification & application.

**CO2:** Apply basic transformation related to the movement of manipulator of robot system.

**CO3:** Analyze basic principle integration.

**CO4:** Design a robot mechanism to meet kinematics requirement.

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| | | End Sem | Mid-Sem Exam | Quiz/ Assignment | End Sem | Lab work | | | | | |
| EE61C | Wind & Solar Energy Systems | 70 | 20 | 10 | - | - | 100 | 3 | 1 | - | 4 |

## WIND & SOLAR ENERGY SYSTEMS

**Module -I: Introduction to Wind Energy:**
Basic Introduction of renewable energy, Energy available from wind, basics of lift and drag, basics of wind energy conversion system, effect of density, angle of attack and wind speed, windmill rotors, horizontal and vertical axes rotors, drag, lift, torque and power coefficients, tip speed ratio, solidity of turbine, wind turbine performance curves, wind energy potential and site selection, basics of wind farm Development of Wind Power Generation.

**Module -II: Wind Energy Systems:**
Wind Power Conversion, Power Equation for wind turbine, Power converter for Wind Turbines, Control and Grid requirement for Modem Wind Turbines, Types of Wind Generators, Singly Excited Induction Generator (SEIG), Standalone operation of fixed and variable speed energy conversion systems, Capacitance Requirement, Doubly Fed Induction Generator (DFIG): Principle, Operation and their analysis, Vector Control of DFIG using an AC-DC AC converter, DFIG based Wind Energy Conversion Systems.

**Module -III: Introduction to Solar Energy:**
Energy available from the sun, spectral distribution, solar radiation outside the earth's atmosphere and at the earth's surface, solar radiation geometry, Instruments for solar radiation measurements, empirical equations for prediction of availability of solar radiation, radiation on tilted surface.

**Module -IV: Solar Energy Systems:**
Solar energy conversion into heat, types of solar collectors, evacuated and non-evacuated solar air Heater, concentrated collectors, thermal analysis of liquid flat plate collector, air heater and cylindrical solar energy thermal storage, heating and cooling of solar drier, solar refrigeration and air Conditioning, solar pond, heliostat, solar furnace photovoltaic system for power generation, Solar cell modules and arrays, solar cell types, material.

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**Module -V: Economic Analysis:**
Initial and annual cost, basic definitions, present worth calculations, repayment of loan in equal annual installments, annual savings, cumulative saving and life cycle cost, economic analysis of add on solar system, payback period, and clean development mechanism.

**Text Books:**

1. S. P. Sukhatme and J. K.Nayak, "Solar Energy Principles of Thermal Collection and Storage", McGraw Hill Education, Third Edition.
2. S. Sivanagaraju Pearson, "Generation and Utilization of Electrical Energy", New Delhi Second Edition.

**Reference Books:**

1. John A. Duffie, William A. Beckman, John Wiley, "Solar Engineering of Thermal Processes", New York, Fourth Edition.
2. Frank Krieth & John F Kreider, John Wiley "Principles of Solar Energy", New York, Third Edition.
3. Joshua Earnest, "Wind Power Technology, PHI, India Learning, New Delhi, Third Edition.

**Course Code : EE61C**
**Course Category : PEC**
**Course Name : Wind & Solar Energy Systems**

After the completion of the course, the students will be able to-

**CO1:** Explain constant wind power plant.

**CO2:** Compare different variable speed wind power plant.

**CO3:** Design Different Solar based Applications.

**CO4:** Carry out preliminary economic analysis of RE systems.

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| EE62A | Engineering Economics & Management | 70 | 20 | 10 | - | - | 100 | 3 | 1 | - | 4 |

## ENGINEERING ECONOMICS & MANAGEMENT

**Module-I:**
Introduction to Engineering Economics and Managerial Economics Concept of Efficiency, Theory of demand, Elasticity of demand, Supply and Law of Supply in difference curves, Budget line, Welfare Analysis, Scope of Managerial Economics, Techniques and Applications of Managerial Economics.

**Module-II:**
Market Structure Perfect Competitions Imperfect – Monopolistic, Oligopoly, Duopoly sorbent features of price determination and Various Market Conditions.
Demand forecasting and cost estimation characteristics of forecasts, Forecasting Horizons, Steps to Forecasting, Forecasting Methods, Seasonal Adjustments, Forecasting Performance Measures, Cost Estimation, Elements of Cost and Computation of Material Variances, Break-Even Analysis.

**Module-III:**
Introduction: Concept, Development, Application and Scope of Industrial Management. Productivity: Definition, Measurement, Productivity Index, Types of Production System, Industrial Ownership.

**Module-IV:**
Management aspects, Functions of Management, Project Management, Value Engineering, Project Evaluation, Work Simplification- Process charts and Flow Diagrams, Production Planning, Decision Making.

**Module-V:**
Quality Control: Process Control, SQC, Control Charts, Single, Double and Sequential Sampling, Introduction to TQM.

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**Text Books:**

1. P.C. Tripathi & P.N. Reddy "Principles of Management", Fourth Edition.
2. Riggs J.L,"Engineering Economy", McGraw Hill, Fourth Edition.

**Reference Books:**

1. T.R. Banga and S.C. Sharma, "Mechanical Estimation and Costing", Seventeenth Edition 2015.
2. Thuesen H.G. "Engineering Economy", PHI,India,Fourth Edition.
3. Robert Lousier- Thomson,"Managements Fundamentals-Concepts, Applications, Skill Development "Third addition.

**Course Code : EE62A**
**Course Category: OEC**
**Course Name : Engineering Economics and Management**

After completion of this course students will be able to-

**CO1:** Understand the key management concepts, principles and contribution by different management thinkers.

**CO2:** Analyze and design organization for effective management.

**CO3:** Application of modern Management Techniques.

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| EE62B | Digital Control System | 70 | 20 | 10 | - | - | 100 | 3 | 1 | - | 4 |

## DIGITAL CONTROL SYSTEM

**Module-I:**
**Introduction:** Digital Control Systems, quantization and quantization error, Z-transform, Z-transforms of elementary functions, properties of Z-transform, Inverse Z-transform, Z-transform method for solving difference equations

**Module-II:**
**Z-plane Analysis of Discrete time Control Systems:** Introduction, Impulse sampling and data hold, pulse transfer function, realization of digital controllers and digital filters

**Module-III:**
**Design of Digital control systems by Conventional methods:** Introduction, Mapping between s-plane and z-plane, transient and steady-state response analysis, Design based on frequency response methods, Analytical Design method.

**Module-IV:**
**State Space Analysis:** State space representation of digital systems, solving discrete state space equations, pulse transfer function matrix, discretization of continuous time state space equations, Liapunov stability analysis.

**Module-V:**
**Pole placement and State Observers design:** Controllability, Observability, useful transformations of state space analysis and design, Design through pole placement, state observer

**Text Books:**
1. I H Nagrath, "State Space methods and digital control systems", New Age International, Seventh Edition.
2. M.Gopal, "Digital Control and state variable Methods", Tata McGraw Hill, Fourth Edition.

**Reference Book:**
1. Katsuhiko Ogatta, "Discrete time Control Systems", Prentice Hall of India, Second Edition.

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**Course Code : EE62B**
**Course Category: OEC**
**Course Name : Digital control system**

After successful completion of the course, student will be able to-

**CO-1:** Acquire the knowledge of digital control system concepts. (Blooms cognitive level 1, 2)

**CO-2:** Analyse the considered digital control systems using state space and z domain technique (Blooms cognitive level 5)

**CO-3**: Design a digital controller to meet given performance specifications using conventional and recent methods (Bloom cognitive level -6)

**CO-4:** Examines the stability of the considered digital control systems using various techniques (Bloom cognitive level 5)

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| | | End Sem | Mid-Sem Exam | Quiz/ Assignment | End Sem | Lab work | | | | | |
| EE62C | Data Structure | 70 | 20 | 10 | - | - | 100 | 3 | 1 | - | 4 |

## DATA STRUCTURE

**Module-I:**
Linear Data Structures - Sequential representations - Arrays and Lists, Stacks, Queues and DE queues, strings, Application, Representation - Linear linked lists, circularly linked lists, Doubly linked lists, Application.

**Module-II:**
Recursion - Design of recursive algorithms, Tail Recursion, When not to use recursion, Removal of recursion.

**Module-III:**
Non-linear Data Structure: Trees - Binary Trees, Traversals and Threads, Binary Search Trees, Insertion and Deletion algorithms, Height-balanced and weight-balanced trees, B-trees, B + - trees, Application of trees; Graphs - Representations, Breadth-first and Depth-first Search.

**Module-IV:**
Hashing - Hashing Functions, collision Resolution Techniques, Sorting and Searching Algorithms, Bubble sort, Selection Sort, Insertion Sort, Quick sort, Merge Sort, Heap sort and Radix Sort.

**Module-V:**
File Structures - Sequential and Direct Access. Relative Files, Indexed Files - B+ - tree as index. Multi- indexed Files, Inverted Files and Hashed Files.

**Text books:**


1. O.G. Kakde and U.A. Deshpande , "Data Structures and Algorithms", First Edition.
2. Aho Alfred V., Hopperoft John E., UIlman Jeffrey D., "Data Structures and Algorithms", Addison Wesley, First Edition.
3. Drozdek A , "Data Structures and Algorithms",Fourth Edition.
4. Pujari A.K., "Data Mining & Techniques", Universities Press, First Edition.
5. Ajay Agarwal, "Data Structure Through C", Cyber Tech.


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**Reference Books:**


1. Heileman: data structures algorithms & OOP Tata McGraw Hill.
2. Data Structures Using C – M.Radhakrishnan and V.Srinivasan, ISTE/EXCEL BOOKS.
3. Weiss Mark Allen, "Algorithms, Data Structures, and Problem Solving with C++", AddisonWesley,First Edition.
4. Horowitz Ellis & Sartaj Sahni, "Fundamentals of Data Structures", Galgotria Pub,Second Edition.
5. Tanenbaum A. S. , "Data Structures using 'C' ".


**Course Code : EE62C**
**Course Category : OEC**
**Course Name : Data Structure**

After successful completion of the course, students will be able to-

**CO1:** Describe various Data Structure

**CO2:** Apply the concept of various data structure to right algorithms.

**CO3:** Analyze various searching and sorting algorithms.

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| EE63 | Microprocessor & Microcontroller | 70 | 20 | 10 | 30 | 20 | 150 | 3 | - | 2 | 4 |

## MICROPROCESSOR & MICROCONTROLLER

**Module-I:**
Microprocessor 8086: Introduction to 16-bit 8086 microprocessors, architecture of 8086, pin configuration, interrupts, minimum mode and maximum mode, timing diagram, Memory interfacing, Comparative study of Salient features of 8086, 80286 and 80386.

**Module-II:**
Microprocessor 8086 Programming: Introduction set of 8086, Addressing modes, assembler directives & operations, assembly and machine language programming, subroutine call and returns, Concept of stack, Stack structure of 8086, timings and delays.

**Module-III:**
Input-Output interfacing: Memory Mapped I/O and Peripherals I/O. PPI 8255 Architecture and modes of operation, interfacing to 16-bit microprocessor and programming, DMA controller (8257) Architecture, Programmable interval timer 8254, USART 8251, 8-bit ADC/DAC interfacing and programming.

**Module-IV:**
Microcontroller 8051: Intel family of 8-bit microcontrollers, Architecture of 8051. I/O Configuration, interrupts, Interrupt structure and interrupt priorities, port structure and operation, accessing internal & external memories and different mode of operation, Memory organization, addressing mode, instruction set of 8051 and programming.

**Module-V:**
8051 Interfacing, Applications and serial communication: 8051 interfacing to ADC and DAC, Stepped motor interfacing, Timer/counter function, 8051 based thyristor firing circuit, 8051 connections to Rs-232, 8051 Serial communication, Serial communication modes, Serial communication programming, Serial port programming in C,PLC Controller.

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**Text Books:**

1. Hall Douglas V, "Microprocessor and interfacing, Programming and Hardware", Macmillan McGraw Hill, Second Edition.
2. Ray A.K. Burchandi K.M., "Advance microprocessor and peripherals", TMH ,First Edition.
3. V. Udayashankara and SJ.S. Mallikarjunaswany, "8051 Mictocontroller," McGraw Hill, First Edition.

**Reference Books:**

1. Kenneth J. Ayala, "The 8086 microprocessors Programming and interfacing the PC,First Edition.
2. Muhammad Ali Mazidi and Janice Gillespie Mazidi, "The 8051 Microcontroller and Embedded Systems", Pearson education, Second Edition.
3. Kenneth J. Ayala, "The 8051 Microcontroller Architecture", Third Edition,
4. Microsoft, "Notes on Microprocessor & Microcontroller".

**List of Experiments:**

1. To add two binary numbers each 8 byte long in 8086
2. To sort a string of 8-bit numbers in descending order in 8086
3. Program for searching for a number or character in a string for 8086
4. Program for string manipulations for 8086.
5. Interfacing ADC and DAC to 8086.
6. Write a program to add/ subtract two 8-bit numbers in 8085 and check for carry/ burrow
7. Assembly Language Programs of Microcontroller 8051
8. USART Operation in 8051.
9. Assembly Language Programs of Interfacing chips

**Course Code : EE63**
**Course Category : PCC**
**Course Name : Microprocessor &Microcontroller**

After completion of this course student will be able to-

**CO1:** Understand the working of processor and develop 8086 assembly level programs

**CO2:** Apply 8051 to interface peripheral and IOS in interrupt driven data transfer mode.

**CO3:** Interface various peripheral ICs like 8255, 8257, 8251,8254 with 8086 and Microprocessor.

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| EE64 | Power Electronics-II | 70 | 20 | 10 | 30 | 20 | 150 | 3 | - | 2 | 4 |

## POWER ELECTRONICS-II

**Module-I: DC Chopper**
Basic chopper classification and operation, Principles of step down & step-up choppers, Chopper configurations and operation with R-L load, Four quadrants choppers, Jones and Morgan Chopper, Effects of source inductance, switched mode power suppliers. A.C.Choppers.

**Module-II: DC – DC Converters**
Linear regulators, Direct DC/DC converters: Buck, Boost, Buck-Boost, Cuk, Fly converters.

**Module-III: Inverter Circuits**
Classification of Inverters, Voltage Source Inverters and Current Source Inverters, Series and Parallel Inverters, Voltage control techniques: Single Pulse, Multiple pulse and Sinusoidal Pulse modulation technique.

**Module-IV: Single Phase Inverters**
Single Phase thyristorised bridge inverter: Steady state and Fourier analysis, Forced Commutated inverter: McMurray and McMurray-Bedford Inverter. Performance parameters: Harmonics and its generation in inverters, Harmonic factor, THD, Distortion factor and LOH in DC supply.

**Module-V: Three Phase Inverters**
Three Phase thyristorised inverter: 120- and 180-degrees operation. Performance parameters of inverter circuit. Introduction to Multi Level Inverters.

**Text Books:**


1. M.H.Rashid," Power Electronics Circuit, Devices & Applications", Person publication, Fourth Edition.
2. P.C.Sen, "Power Electronics", TMH publication, Second Edition.
3. Jai P. Agrawal, "Power Electronics Systems, Pearson Education, Fourth Edition.


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**Reference Books:**


1. Robert W. Ericksion Dragan Maksimovic,"Fundamentals of Power Electronics",Springer, Third Edition.
2. Daniel W. Har, "Power Electronics", McGraw-Hill Publication.
3. M.D.Singh, K.B.Khanchandani," Power Electronics", TMH, Delhi,Second Edition.
4. Chakravarti A.," Fundamental of Power Electronics and Drives", Dhanpat Rai & Co.
5. Vedam Subramanyam," Power Electronics" New Age International Revised Second Edition.
6. Philip T. Krein, "Elements of Power Electronics", Oxford University Press, First Edition.
7. Randal Shaffer, "Fundamental of Power Electronics with MATLAB learning".


**List of Experiments:**

1. Analysis of step up and step down Chopper.
2. Analysis of Jones Chopper.
3. Analysis of Morgan Chopper.
4. Experiment with buck Converter
5. Experiment with boost Converter
6. Series and Parallel Inverter.
7. Analysis of McMurray Inverter
8. Analysis of Three phase Thyristorised Inverter.

**Course Code : EE64**
**Course Category : PCC**
**Course Name : Power Electronics-II**

After completion of this course student will be able to-

**CO1:** Analysis of DC-DC Chopper Circuit.

**CO2:** Analysis of regulated DC Power Supply.

**CO3:** To understand the Operation of DC-AC Power Electronics circuit.

**CO4:** Introduction of Harmonics in DC Power supply.

**CO5:** Analysis of single phase and three phase Inverter circuit.

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**(Declared Autonomous by MP Govt., Affiliated to RGPV, Bhopal)**
**(AICTE Model Curriculum Based Scheme)**
**Bachelor of Technology (B.Tech.) VI Semester (Electrical Engineering)**

## COURSE CONTENTS

w.e.f. July2023

| Subject Code | Subject Name | Maximum Marks Allotted | | | | | | Hours/ Week | | | Total Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Theory | | | Practical | | Total Marks | L | T | P | |
| | | End Sem | Mid-Sem Exam | Quiz/ Assignment | End Sem | Lab work | | | | | |
| EE65 | Modern Power System | 70 | 20 | 10 | 30 | 20 | 150 | 3 | - | 2 | 4 |

## MODERN POWER SYSTEM

**Module –I: Power System Network Matrices**
Graph Theory: Definitions, Tree and co-trees, cut-sets and loops, Bus Incidence Matrix, Ybus formation by Direct and Singular Transformation Methods, Numerical Problems. Formation of Partial Zbus partial network, Algorithm for the Modification of Zbus Matrix for addition element for the following cases: Addition of element from a new bus to reference, Addition of element from a new bus to an old bus, Addition of element between an old bus to reference and Addition of element between two old buses (Derivations and Numerical Problems). - modification of Zbus for the changes in network (Problems)

**Module –II:Power flow Studies-1**
Necessity of Power Flow studies, Data for Power Flow Studies, Derivation of Static load flow equations, Load flow solutions using Gauss seidel method: Acceleration Factor, Load flow solution with and without P-V buses, Algorithm and Flowchart. Numerical Load flow solution for Simple Power Systems (Max. 3-Buses): Determination of Bus Voltages, Injected Active and Reactive Powers (Sample One Iteration only) and finding Line Flows/Losses for the given Bus Voltages

**Module –III: Power flow Studies-2**
Newton Raphson Method in Rectangular and Polar Co-Ordinates Form: Load Flow Solution with or without P-V Busses- Derivation of Jacobian Elements, Algorithm and Flowchart. Decoupled and Fast Decoupled Methods. - Comparison of Different Methods — DC load Flow

**Module –IV: Power System Steady State Stability Analysis**
Elementary concepts of steady state, Dynamic and Transient Stabilities. Description of steady state stability, Power Limit, Transfer Reactance, Synchronizing Power Coefficient, Power Angle Curve and Determination of Steady State Stability and Methods to improve steady state and transient stability, Swing equation, Equal area criterion, Critical Clearing Time and Critical Clearing Angle

**Module-V: SCADA system and Smart Grid**
**SCADA SYSTEM:** Need of computer control of power systems, Data acquisition and control, SCADA System evolution, SCADA System architecture, SCADA System desirable properties, Remote Terminal Unit, IED, Autorecloser, sectionalizers, Ring Main units, Fault passage indicators, SCADA human – machine interface (HMI)

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**SCADA Protocols-** Evolution of SCADA Protocols, Proprietary and open protocols , OSI Model, TCP/IP Model, Modbus, DNP3, UCA, IEC 61850 Standards,
**Smart Grid-** Principle and architecture of Smart Grid, Self healing and adaptive grids, Key drivers, components of smart grid, smart grid management center, Advance metering infrastructure for smart grid , Smart meters , head end system, Zigbee and home area network (HAN), Phasor measurement unit (PMU),

**Text Books:**


1. Abhijit Chakrabarti, Sunita Halder, "Power System Analysis Operation and Control", PHI Publication,Fourth Edition.
2. I.J. Nagrath & D.P.Kothari, "Modern Power systemAnalysis", Tata McGraw-Hill Publishing company, Second Edition.


**Reference Books:**


1. Grainger and Stevenson, "Power System 'Analysis", data McGraw Hill.
2. A.R. Bergen, "Power System Analysis", Prentice Hall. Inc.
3. Hadi Saada,t,"Power System Analysis", TMH Edition.
4. B.R. Gupta, "Power System Analysis", Wheeler Publications.
5. M.A.Pai, "Computer Techniques in Power System Analysis", TMH Publications.


**List of Experiments:**

1. Write a program in MATLAB/Python to formulate Y bus matrix of a given system.
2. Develop a power system and perform load flow analysis in MATLAB Simulink.
3. Write a program in MATLAB/Python to perform load flow analysis using Gauss siedel methods.
4. Write a program in MATLAB/Python to perform load flow analysis using Newton Raphson methods.
5. Perform an experiment for transient stability analysis of IEEE 6 bus system in MATALB/Python.
6. Perform an experiment for fault analysis in power system.

**Course Code : EE65**
**Course Category : PCC**
**Course Name : Modern Power System**

After completion of this course student will be able to-

**CO1:** Use power flow methods in the power-flow problem (hand calculation and simulation)

**CO2:** Calculate power system admittance and impedance matrices.

**CO3:** Analyze and determine Power System steady state and transient stability.

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